Instrument Incubator

SRI CubeSat Imaging Radar for Earth Science: Instrument Development and Demonstration (CIRES-IDD)

Completed Technology Project (2017 - 2020)

Project Introduction

Space-based interferometric synthetic aperture radar (InSAR) is a key change-detection tool in NASA's Earth Science Division portfolio. InSAR addresses three of the seven major themes summarized by the National Research Council Earth Sciences Decadal Survey: 1) solid-earth hazards and dynamics; 2) human health and security; and 3) land-use change, ecosystem dynamics, and biodiversity. All require global, frequent assessments of solid surface deformation via InSAR measurements. For maximum impact, InSAR measurements must be precise (sub-cm level) and timely. Frequent acquisitions (sub-weekly) are needed to provide enhanced deformation precision through time series averaging, and ensure that an event is properly captured and characterized. Orbital mechanics prevent single-platform sensors from simultaneously achieving rapid revisit times and wide-area coverage. Multiple platforms are needed to avoid compromising coverage, but traditional InSAR sensors are too expensive (> $300M) to replicate. Under the NASA ESTO IIP program, SRI International (SRI) and our team of collaborators propose to develop a complete SAR/InSAR instrument for CubeSats. The instrument is called CIRES-IDD (CubeSat Imaging Radar for Earth Science – Instrument Development and Demonstration). We will leverage SRI's TRL-5 CIRES radar hardware developed under NASA ACT funding, SRI's TRL 4 image formation software, and a TRL-3 high-gain deployable membrane antenna to form the complete instrument. CIRES-IDD is a three-year program with ground and airborne unmanned aerial systems (UAS) demonstrations to retire technology risks and raise the CIRES-IDD system TRL from 3 to 6 in preparation for a future orbital demonstration campaign. The planned IIP period of performance is from 9 January 2017 to 8 January 2020. The following points summarize the maturation plan for each technology piece. We will start by maturing the SAR/InSAR image-processing solution. SRI will apply their extensive set of SAR algorithms and coherent registration techniques to CIRES-IDD. We will test and debug the developed software on the UAS platform, followed by a rigorous calibration campaign. SRI experience with adapting the image formation tools to different systems (e.g., operational TRL-9 airborne radar systems) enables a relatively straightforward algorithm development path based on previously proven techniques. Our antenna partner, Physical Sciences Inc. (PSI), will develop the high-gain deployable membrane antenna (>36 dBi). PSI will iteratively develop and test increasing scales of antenna test articles, focusing on deployment, tensioning, packaging efficiency, and RF performance. Antenna risk reduction tests will include microgravity deployment and folding tests, among others. Working with NASA Ames Research Center and the NASA Airborne Science Program, we will execute four UAS flight campaigns to validate CIRES-IDD utility at altitude. These flights will demonstrate the full SAR/InSAR performance capabilities (25-m imaging resolution, sub-cm-level InSAR accuracy, SNR >13 dB) and demonstrate scientific relevance. We have partnered with Jet Propulsion Laboratory, Stanford University, and the U.S. Geological Survey to identify local areas of interest and assist with analyzing and assessing the utility of the

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Organizational Responsibility

Responsible Mission Directorate:

Science Mission Directorate (SMD)

Lead Organization:

SRI International

Responsible Program:

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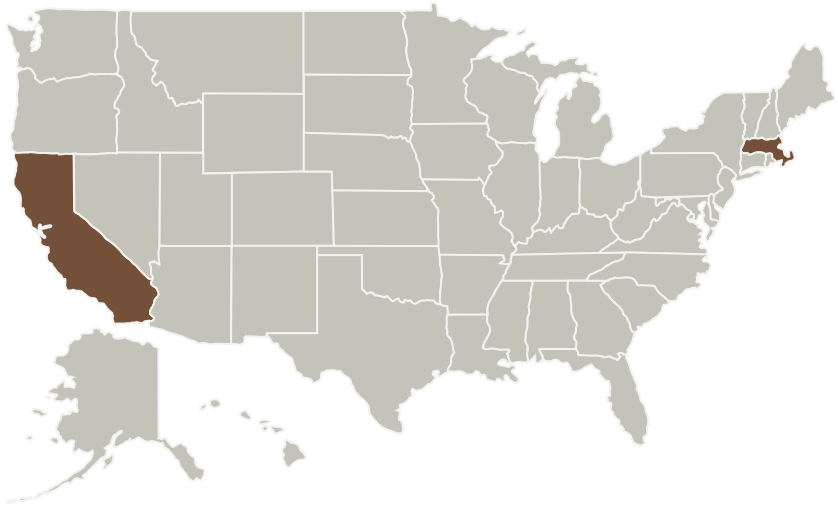
data for scientific research. The lessons learned from UAS testing will be used to optimize the CIRES-IDD design features such as thermal resilience, power management, mass, volume, and sensor capabilities, thereby improving system performance and reducing risks for future on-orbit operations. Although the proposed project's ultimate goal is to prepare and prove CIRES-IDD for future on-orbit CubeSat operations, the UAS SAR system resulting from this effort will become a useful scientific research platform in its own right, a capability also valued in the Decadal Survey.

Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
SRI International	Lead Organization	Industry	Menlo Park, California

Primary U.S. Work Locations	
California	Massachusetts

Project Management

Program Director:

Pamela S Millar

Program Manager:

Parminder S Ghuman

Principal Investigator:

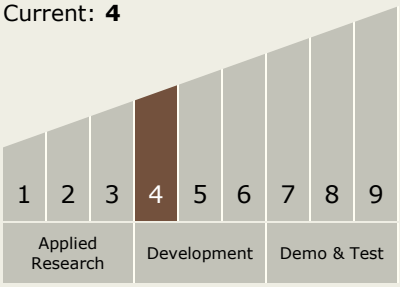
Lauren Wye

Co-Investigators:

Jonathan D Stock
Howard A Zebker
Peter A Warren
Sang-ho Yun
Zach Tyler
Simon Lee

Technology Maturity (TRL)

Start: **4**
Current: **4**



Technology Areas

Primary:

- TX08 Sensors and Instruments
  - TX08.2 Observatories
    - TX08.2.3 Distributed Aperture

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Target Destination

Earth